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13. ABSTRACT *(Maximum 200 words)*

The first estimate of the universal form of the atmospheric temperature spectrum for locally stationary conditions was obtained with a statistical accuracy exceeding 5%. The universal form of the temperature spectrum permitted the accurate estimation of the statistics of the locally-stationary inner scale, structure constant, energy dissipation rate, and rate of dissipation of temperature variance. All these parameters have a log-normal distribution. The accuracy of the locally-stationary universal spectrum and estimates of the parameters of the spectrum were determined by a Monte-Carlo simulation. These simulations indicate the feasibility of 4% accuracy for inner scale estimates and 8% accuracy for estimates of the structure constants using 1 second of data. The average temperature spectrum is not a universal function and depends on meteorological conditions. The fluctuations in the locally stationary parameters produce a bias (which depends on experimental conditions) in the estimation of the universal Obukhov-Corrsin constants and the Kolmogorov constant. The variations in inner scale and level of turbulence are large (a factor of 10 for level of turbulence and a factor of 4 for inner scale over a few minutes). These variations may have pronounced effects on imaging systems and boundary layer mechanisms. A rugged laser instrument can be constructed to accurately measure many of the important boundary layer parameters.

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A. Statement of the Problem

The temperature spectrum for locally-stationary conditions in the atmoshperic surface layer can be determined by measurements of laser scintillation. The improved performance of the path-averaging scintillation statistics should provide an accurate estimate of the universal form for the temperature spectrum. The fluctuations in the resulting turbulence parameters provide new information about the boundary layer turbulence processes. The performance of scintillation measurements can be determined by Monte-Carlo simulations to verify the results and to design improved experiments.

B. Summary of Research Findings

The detailed results of this work are contained in papers listed in the "Publications" section.

1) The universal form of the atmospheric temperature spectrum for locally stationary conditions was obtained with a statistical accuracy exceeding 5%. The universal spectrum exhibits the bump at the temperature microscale due to the viscous-convective regime. This is the first estimate of the turbulence spectrum for locally stationary conditions.

2) The universal form of the temperature spectrum permitted the accurate estimation of the statistics of the locally-stationary inner scale, structure constant, energy dissipation rate, and rate of dissipation of temperature variance. All these parameters have a log-normal distribution.

3) The accuracy of the locally-stationary universal spectrum and estimates of the parameters of the spectrum were determined by a simulation of the data for known conditions. These simulations indicate the feasibility of 4% accuracy for inner scale estimates and 8% accuracy for estimates of the structure constants using 1 second of data and probing 10 to 50 meters of the atmospheric boundary layer. The accuracy of the estimates is related to the number of independent samples which can also be determined from the data.

4) The average temperature spectrum was calculated by averaging over the variations in inner scale and structure constant. Since the parameters of the lognormal distribution are not invariant with time, the average temperature spectrum is not a universal function and depends on meteorological conditions.

5) The fluctuations in the locally stationary parameters produce a bias in the estimation of the universal Obukhov-Corrsin constants and the Kolmogorov constant. The magnitude of this bias was estimated for the conditions of the experiment. The bias will depend on meterological conditions since the parameters of the log-normal distribution are not constant with time.

6) The variations in inner scale and level of turbulence are large (a factor of 10 for level of turbulence and a factor of 4 for inner scale over a few minutes). These variations may have pronounced effects on imaging systems and boundary layer mechanisms.

7) The feasibility of a compact solid-state laser scintillation instrument for accurately estimating many of the important boundary layer parameters has been demonstrated.

8) A new method for precise measurements of the voltage response function of photodetectors was developed and submitted to Applied Optics.

C. Publications

"Laser Scintillation Measurements of the Temperature Spectrum in the Atmospheric Surface Layer", R. G. Frehlich, submitted to the Journal of the Atmospheric Sciences.

"Estimation of the Nonlinearity of a Photodetector", R. G. Frehlich, submitted to Applied Optics.

"Measurements of the Atmospheric Turbulence Spectrum and Intermittency using Laser Scintillation", Proc. SPIE, in press, (1991).

D. Scientific Personnel

The scientific personnel supported by this proposal include the Principal Investigator, Rod Frehlich, and an undergraduate student, Ethan Alpert.